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A nonwoven fabric containing sheath-core type bicomponent fibers and a method thereof

Technical Field

The present invention relates to a nonwoven fabric which is comprised of specific sheath-core type bicomponent fibers. And the nonwoven fabric has an excellent property into softness and adhesion by heating. Furthermore, the invention relates to a method of the nonwoven fabric.

Background Art

A nonwoven fabric is known which is composed of sheath-core type bicomponent fibers. Especially, it is known that a nonwoven fabric is composed of sheath-core type bicomponent continuous fibers each of which is consisted of a sheath portion made of polyethylene and a core portion made of polyester, and the nonwoven fabric is used as a heat sensitive adhesive nonwoven fabric (JP 8-14069 B, claim 1 in page 1).

The heat sensitive adhesive nonwoven fabric is laminated to an other material etc., and is heated and if necessarily pressed. Then, the heat sensitive adhesive nonwoven fabric is adhered to the other materials by melting or softening the polyethylene only of the sheath portion, because the heat sensitive adhesive nonwoven fabric is composed of the sheath-core type bicomponent continuous fibers each of which is consisted of the sheath portion made of the polyethylene having low melting point and the core portion made of the polyester having high

melting point.

Summary of the Invention

The inventor has investigated to lower the melting point of the polyethylene in order to improve adhesive property of the heat sensitive adhesive nonwoven fabric. In this investigation, using a specific polyethylene instead of the conventional polyethylene, the inventor has discovered that a specific sheath-core type bicomponent continuous fiber is obtained which is distinguished from the above said conventional sheath-core type bicomponent continuous fiber. That is, the inventor has discovered that the surface of specific bicomponent continuous fiber is irregularly uneven. The inventor has further discovered that the specific bicomponent continuous fiber has not a constant diameter, that is, has thin diameter parts and thick diameter parts, therefore the fiber is very soft because of the thin diameter parts. Accordingly, the nonwoven fabric consisted of the specific bicomponent continuous fibers is very soft.

The object of the invention is to provide a very soft nonwoven fabric based on the above discovery.

The invention relates to the nonwoven fabric containing specific sheath-core type bicomponent fibers. The sheath portion of the bicomponent fiber is formed by polyethylene, and the thickness of the sheath portion is changed irregularly and at random along the axial direction and circular direction of the fiber. The core portion of the bicomponent fiber is formed by polyester, and the configuration of the

core portion is not substantially changed along the axial direction of the fiber.

Description of the Invention

The nonwoven fabric is containing the specific sheath-core type bicomponent fibers. The sheath-core type bicomponent fiber may be a staple fiber or a continuous fiber (filament). The continuous fiber may be suitable because of generally using a spunbond process to obtain the nonwoven fabric of the invention. The sheath-core type bicomponent fiber is consisted of the sheath portion made of polyethylene and the core portion made of polyester. Since the solubility of the polyethylene and the polyester is moderately poor, the specific sheath-core type bicomponent fiber may be obtained. If the core portion is formed by polypropylene which has good solubility to polyethylene, it is difficult to obtain the specific sheath-core type bicomponent fiber. And if the core portion is formed by polyamide which has very poor solubility to polyethylene, it is too difficult to obtain the specific sheath-core type bicomponent fiber.

The configuration in cross section of the core portion is not substantially changed along the axial direction of the fiber as same as the prior arts. Typically, the configuration in cross section of the core portion may be a circle, and the diameter of the circle is not substantially changed along the axial direction of the fiber. The polyester forming the core portion may be polyethylene-terephthalate marketed or used industrially, especially marketed or used on textile industry. Concretely, it is suitable to use polyethylene-terephthalate

of which the limiting viscosity is 0.50- 1.20.

The surface of the specific sheath-core type bicomponent fiber, that is, the surface of the sheath portion is irregularly uneven. The irregular unevenness comes out because the thickness of the sheath portion changes unequally and at random along the axial direction and circular direction of the fiber. The thickness of the sheath portion is zero in a part which is not having the sheath portion, that is, in the part which the core portion is exposing. When the diameter of the core portion is ϕ_0 , and the diameter of the bicomponent fiber in the part having most thick sheath portion is ϕ_1 , the diameter of the bicomponent fiber changes at random in the range of $\phi_0 \sim \phi_1$ along the axial direction of the bicomponent fiber. Concurrently, the radius of the core portion is $\phi_0 /2$, and the radius of the bicomponent fiber in the part having most thick sheath portion is $\phi_1 /2$, the radius of the bicomponent fiber changes at random in the range of $\phi_0 /2 \sim \phi_1 /2$ along the circular direction of the bicomponent fiber. However it is described in the above case that the configuration of the cross section of the core portion and the bicomponent fiber is circle, the configuration may be not circle. In the case the configuration is not circle, the diameter or the radius means a diameter or a radius of imaginary circle corresponding to cross section area of the bicomponent fiber.

It is suitable to use a mixture of a first polyethylene having high spinnability and a second polyethylene having low spinnability as the polyethylene forming the sheath portion. When using only the first

polyethylene having high spinnability, it is difficult to come out irregular unevenness. That is, the bicomponent fiber may be same as that of the prior art. On the other hand, using only the second polyethylene having low spinnability, it is difficult to obtain the bicomponent fiber by the process of melt spinning. It is suitable to mix 30-70 weight % of the first polyethylene and 70-30 weight % of the second polyethylene. As the first polyethylene, it is most suitable to use the polyethylene polymerized by metallocene catalyst. Because, the polyethylene polymerized by metallocene catalyst has low melting point and high spinnability. As the second polyethylene, it is common to use the polyethylene polymerized by Ziegler-Natta catalyst, that is, sold industrially. It is most suitable to use the low density polyethylene which has low melting point and low spinnability. The low density polyethylene may be 0.910 - 0.925 g/cc of density.

It is suitable that the weight mass of the sheath portion is 20-300 weight mass per 100 weight mass of the core portion. The weight ratio means an average, because the thickness of the sheath portion is changing irregularly or at random along the axial direction and circular direction of the fiber. If the weight mass of the sheath portion is lower than 20 weight mass, it is difficult to obtain high adhesive strength, in the case of using the sheath portion as an adhesive agent. If the weight mass of the sheath portion is higher than 300 weight mass, the weight mass of the core portion is relatively smaller. Accordingly, because the diameter of the core portion becomes

fine, the tensile strength is lower in the part which the core portion is exposing, that is, the sheath portion is not existing.

It is suitable that a fineness of the specific sheath-core type bicomponent fiber is 1.0-10 dtex. The fineness means an average because a fineness changes irregularly or at random along the axial direction of the fiber.

The forms of the specific sheath-core type bicomponent fibers are shown in the figure 1-3. An inside between two parallel straight lines expresses the core portion. As shown, the diameter of the core portion does not substantially change. The sheath portion is expressed by surges which are existing on the upper and the lower of the two parallel straight lines. As clearly shown, the thickness of the sheath portion changes irregularly or at random along the axial direction and circular direction of the fiber. Figure 8 shows each concrete configuration of cross sections of the bicomponent fibers. It may be understood that the thickness of the sheath portion changes irregularly or at random along the circular direction of the fiber.

A weight of the nonwoven fabric containing the specific sheath-core type bicomponent fibers is not restricted, but it is suitable that the weight is 10-100 g/m^2. When two pieces of the nonwoven fabric are laminated and the edges are adhered by heating, it is possible to obtain a bag. Furthermore, when the nonwoven fabric is laminated with a plastic film, a woven or knitted fabric, a paper, or an other nonwoven fabric and adhered by heat-sealing, it is possible to obtain a composite material. That is, when the heat and if necessarily press

is given to the polyethylene forming the sheath portion, the two pieces of the nonwoven fabric are adhered or the nonwoven fabric is adhered to the other material by the melting or softening polyethylene. Especially, in the case that the polyethylene forming the sheath portion is the mixture of the first polyethylene polymerized by metallocene catalyst and the second polyethylene which is low density polyethylene, it is possible to adhere by heating on lower temperature, because the polyethylene forming the sheath portion has lower melting point. Furthermore, if the other material is the material made of polypropylene, especially polypropylene film, it is possible to obtain a composite material of which the nonwoven fabric and the material are strongly adhered, because the polyethylene forming the sheath portion has good solubility to polypropylene. In the case that the other material is a polyethylene film, it is advantage that the polyethylene film is hardly shrunk, strained and transformed by heating.

A typical method of the nonwoven fabric relating to the invention is comprised of the following steps. The polyester and the polyethylene are prepared. The polyethylene is the mixture of the first polyethylene polymerized by metallocene catalyst and the second polyethylene polymerized by Ziegler-Natta catalyst. The polyester is provided to each core hole of sheath-core type spinning holes. The polyethylene is provided to each sheath hole of the above said spinning holes. By using the above said sheath-core type spinning holes, the polyester and the polyethylene are spinning together, and the specific sheath-core type bicomponent continuous fibers are obtained. The

nonwoven fabric relating to the invention is obtained by accumulating the bicomponent continuous fibers.

As the polyester, the first polyethylene polymerized by metallocene catalyst and the second polyethylene polymerized by Ziegler-Natta catalyst, what were above described are used. The first polyethylene and the second polyethylene are mixed at the above described ratio of weight, and the mixture is used as the polyethylene.

It is suitable that the melt flow rate (MFR) of the polyethylene is 16-21 grams per 10 minutes. In this range, it is easy to form the sheath portion of which the surface is irregular unevenness when spinning at a high speed. However, it is possible to form the sheath portion of which the surface is irregular unevenness, by spinning at a higher speed when the value of MFR is larger than the above range, or by spinning at a lower speed when the value of MFR is smaller than the above range. It is suitable that the value of MFR is in the above range, when spinning at 3000-4000 meters per a minute which is commonly used. It is suitable that the melting point of the polyethylene is lower, especially is 90-110 ℃. Because it is possible to adhere by heating in a low temperature.

The polyethylene and the polyester are heated and molten. The molten polyester is provided to each core hole of the sheath-core type spinning holes in a spinneret. The molten polyethylene is provided to each sheath hole of the above spinning holes. By melt spinning the polyester and the polyethylene, it is possible to obtain the sheath-core type bicomponent continuous fibers of each of which the surface is

irregular unevenness. The invention is characterized by being able to stably obtain the sheath-core type bicomponent continuous fiber of which the surface is irregular unevenness, that is, the diameters of the bicomponent fiber differ in the axial direction of the fiber. On the melt spinning in the prior art, the continuous fiber of which the diameters differed did not be obtained, because the continuous fiber cuts at fine diameter parts. That is, on the conventional melt spinning, in the case that an unevenness is formed on the surface of the fiber, the unevenness is formed just after the melt spinning when the resin as polyester etc. has high fluidity. Because the stress at the melt spinning is centralized in parts of fine diameters for the high fluidity, the spinning fiber is easy to cut in the parts of the fine diameters. Accordingly, the continuous fiber of which the surface is irregular unevenness may not be stably obtained. However, the continuous fiber may be stably obtained by the invention. The principle of the invention may be as the following. That is, using mixture of the first polyethylene and the second polyethylene, the unevenness is not formed just after the melt spinning when the resin as polyester etc. has high fluidity. On the time which the core portion is solidified or after the time, the irregular unevenness may be formed because the polyethylene of the sheath portion is stressed. The reason of the stress of the polyethylene is that the polyethylene is the mixture of the first polyethylene having high spinnability and the second polyethylene having low spinnability. That is, the first polyethylene may form the fiber with the polyester, but the second

polyethylene may obstruct to form the fiber.

After the sheath-core type bicomponent continuous fibers are obtained, the fibers are accumulated on the moving conveyor. A web formed by accumulating the fibers is partially heated and pressed by passing through between a pair of embossing rolls etc.. The sheath portions are molten or softened at the parts which the heat and press are given. The bicomponent fibers are bonded at the parts with each other. And it is possible to obtain the nonwoven fabric which has high tensile strength. The nonwoven fabric comprised of the sheath-core type bicomponent fibers is suitably used to obtain the composite material adhering the nonwoven fabric to the other materials by heating as the above described. Furthermore, the nonwoven fabric is suitably used to obtain the bag of which the edges are adhered by heating as the above described. The nonwoven fabric is used as a material of a garment, of a sanitary, of a industry, of an agriculture and of a living.

The nonwoven fabric relating to the invention is comprised of the sheath-core type bicomponent fibers. The fiber is consisted of the core portion of which the configulation in cross-section is not substantially changed along the axial direction of the fiber and the sheath portion of which the thickness is changed irregularly and at random along the axial direction and circular direction of the fiber. That is, the fiber has parts of fine diameters and parts of thick diameters along the axial direction of the fiber. Softness is given to the fiber because the parts of fine diameters exist. Tensile strength

of the fiber is same as a sheath-core type bicomponent fiber in the prior art, because the diameter of the core portion is not changed along the axial direction of the fiber. Accordingly, the nonwoven fabric comprised of the above said bicomponenet fibers has two properties which are the softness and the high tensile strength.

The sheath-core type bicomponent fiber diffusely reflects visible ray, because the surface of the fiber is irregularly unevenness.

Accordingly, the nonwoven fabric comprised of the fibers may be whitish.

In the case that the polyethylene of the sheath portion is the mixture of the first polyethylene and the specific second polyethylene, the nonwoven fabric may be adhered to other material (included nonwoven fabric) by heating on low temperature. Because the first polyethylene polymerized by metallocene catalyst has low melting point, and, the specific second polyethylene is low density polyethylene which is polymerized by Ziegler-Natta catalyst and has low melting point.

In the method relating to the invention, the sheath portion is formed by the mixture of the first polyethylene having high spinnability and the second polyethylene having low spinnability. When melt spinning this polyethylene, the thick of the sheath portion becomes thickly and thinly at random by the existing of the second polyethylene having low spinnability. On the other hand, the core portion is formed of the polyester, and the diameter of the core portion does not substantially change as the prior art. Accordingly, the sheath-core type bicomponent fiber of the core portion of which the

configuration in cross-section is not substantially changed along the axial direction of the fiber, and of the sheath portion of which the thickness is changed irregularly and at random along the axial direction and the circular direction of the fiber is stably obtained. And the nonwoven fabric comprised of the above fibers is too stably obtained.

Brief Description of Drawings

Figure 1 is a side view (micrograph) showing an example of a sheath-core type bicomponent fiber relating to the invention.

Figure 2 is a side view (micrograph) showing another example of a sheath-core type bicomponent fiber relating to the invention.

Figure 3 is a side view (micrograph) showing a further example of a sheath-core type bicomponent fiber relating to the invention.

Figure 4 is an enlarged view (micrograph) showing a surface of a nonwoven fabric obtained by a method of the following example 2.

Figure 5 is an enlarged view (micrograph) showing a surface of a nonwoven fabric obtained by a method of the following example 3.

Figure 6 is an enlarged view (micrograph) showing a surface of a nonwoven fabric obtained by a method of the following example 4.

Figure 7 is an enlarged view (micrograph) showing a surface of a nonwoven fabric obtained by a method of the following example 5.

Figure 8 is a cross sectional view (micrograph) showing an example of a sheath-core type bicomponent fiber relating to the invention.

Example

The invention is more described on examples as the followings, but the invention is not limited in the range of the examples. The invention may be understood on the discovery that it is stably able to obtain the sheath-core type bicomponent fiber of which the surface (that is, the surface of the sheath portion) has irregular unevenness.

The values or properties in the examples were measured or evaluated as the followings.

(1) Intrinsic Viscosity [η] of the polyester; It was measured by dissolving 0.5 gram of a sample in 100 cc of the solvent which was a mixture of an equal parts of a phenol and an ethane tetrachloride on the condition with 20℃.

(2) Melting Point [℃]; It was measured by using the differential scanning calorimeter DSC-7 provided from PerkinElmer Inc. on the condition that a speed rate of elevating temperature was 20 ℃ per a minute.

(3) Melt Flow Rate (g/10 minutes) of the polyethylene; It was measured by a described method on JIS K 6922 on the conditions with 21.18N of a load and 190 ℃ of a temperature.

(4) Softness (g) of the nonwoven fabric; It was measured by a method of a Handle-O-Meter which was in E method of an article of softness on JIS L 1096.

(5) Soft feeling of the nonwoven fabric; It was evaluated by each feeling of each hand of 5 panelers. Nonwoven fabrics of the examples and the comparative example were relatively evaluated into the following ranks.

1 : It was soft.

2 : It was a little soft.

3 : It was not soft.

(6) Smoothness feeling of the nonwoven fabric; It was evaluated by each feeling of each hand of 5 panelers. Nonwoven fabrics of the examples and the comparative example were relatively evaluated into the following ranks.

Good : It had a very smoothness.

Mid. : It had a smoothness.

Bad : It had little or no smoothness.

(7) Tensile Strength (N/5 cm in width) of the nonwoven fabric; It was measured on JIS L 1096. That was, ten test strips of 50 mm in width and 200 mm in length were prepared. Each test strip was tensioned by using Tensilon RTM-500 provided by Toyo Baldwin on the conditions of 100 mm in distance between chucks and 100 mm/minute in tensile speed. And average tensile strength of ten test strips was the tensile strength. The tensile strengths in MD direction (machine direction) and in CD direction (cross direction to MD direction) were measured.

(8) Adhesion Strength (N) of the nonwoven fabric; Two test strips of 30 mm (CD direction) and 150 mm (MD direction) were laminated. The part which was 50 mm from the edge of length direction (MD direction) was adhered by heating in Heat Seal Tester. The adhesion by heating was carried out at three kinds of temperature which was set up 100℃, 110 ℃ and 130℃ on the die. Furthermore the

pressure was set up 98 N/cm^2, and the area of the adhesion was set up 10 mm (MD direction) and 30 mm (CD direction).

The adhesion strength was measured on the method of T type peeling in JIS L 1089. That was, each of five test adhesive samples was tensioned by Tensilon RTM-500 provided by Toyo Baldwin on the conditions of 10 mm in distance between chucks and 100 mm/minute in tensile speed. An adhesion strength was a strength when the sample was broken. And average adhesion strength of five samples was the adhesion strength.

Example 1

The polyethylene-terephthalate which was 0.70 in intrinsic viscosity [η] and 260 ℃ in melting point was prepared. On the other hand, the polyethylene which was 18 g/10 minutes in melt flow rate, 0.911 g/cc in density and 104℃ in melting point was prepared. This polyethylene was the mixture of the first polyethylene 60 weight mass and the second polyethylene 40 weight mass. The first polyethylene was polymerized by metallocene catalyst and was 28 g/10 minutes in melt flow rate, 0.906 g/cc in density and 97 ℃ in melting point. The second polyethylene was polymerized by Ziegler-Natta catalyst and was 4 g/10 minutes in melt flow rate, 0.918 g/cc in density and 106℃ in melting point.

The polyester was provided to each core hole of the sheath-core type spinning holes and the polyethylene of which the weight was equal to the polyester was provided to each sheath hole of the spinning holes. And the melt spinning was carried out on the conditions with

280℃ in a spinning temperature and 3800 m/minute in a spinning speed. Thereafter, spinned filaments were drafted and fined by a suction device. The spun filaments discharged from the suction device were opened. The spun filaments became to the sheath-core type bicomponent continuous fibers each of which was 3.3 dtex. And the fibers were accumulated on a moving conveyor and a nonwoven web was formed. The nonwoven web was passed through between an embossing roll of which the surface temperature was 95 ℃ and a smooth roll of which the surface temperature was 95℃. Then a total area of convex parts of the embossing roll was 36% per an entire area of the embossing roll. The nonwoven web was partially heated and pressed on the condition with 294 N/cm in line pressure. As the result, the nonwoven fabric was obtained and the weight was 50 g/m^2.

Example 2

The polyethylene-terephthalate which was 0.70 in intrinsic viscosity [η] and 260 ℃ in melting point was prepared. On the other hand, the polyethylene which was 21 g/10 minutes in melt flow rate, 0.913 g/cc in density and 102℃ in melting point was prepared. This polyethylene was the mixture of the first polyethylene 60 weight mass and the second polyethylene 40 weight mass. The first polyethylene was polymerized by metallocene catalyst and was 28 g/10 minutes in melt flow rate, 0.906 g/cc in density and 97 ℃ in melting point. The second polyethylene was polymerized by Ziegler-Natta catalyst and was 14 g/10 minutes in melt flow rate, 0.918 g/cc in density and 106 ℃ in melting point.

Using the polyester and the polyethylene, the nonwoven fabric was obtained and the weight was 50 g/m ^{2} by the same method of the example 1.

Example 3

The polyethylene-terephthalate which was 0.70 in intrinsic viscosity [η] and 260 ℃ in melting point was prepared. On the other hand, the polyethylene which was 18 g/10 minutes in melt flow rate, 0.913 g/cc in density and 104℃ in melting point was prepared. This polyethylene was the mixture of the first polyethylene 40 weight mass and the second polyethylene 60 weight mass. The first polyethylene was polymerized by metallocene catalyst and was 28 g/10 minutes in melt flow rate, 0.906 g/cc in density and 97 ℃ in melting point. The second polyethylene was polymerized by Ziegler-Natta catalyst and was 14 g/10 minutes in melt flow rate, 0.918 g/cc in density and 106 ℃ in melting point.

Using the polyester and the polyethylene, the nonwoven fabric was obtained and the weight was 50 g/m ^{2} by the same method of the example 1.

Example 4

The polyethylene-terephthalate which was 0.70 in intrinsic viscosity [η] and 260 ℃ in melting point was prepared. On the other hand, the polyethylene which was 16 g/10 minutes in melt flow rate, 0.910 g/cc in density and 103℃ in melting point was prepared. This polyethylene was the mixture of the first polyethylene 67 weight mass and the second polyethylene 33 weight mass. The first polyethylene

was polymerized by metallocene catalyst and was 28 g/10 minutes in melt flow rate, 0.906 g/cc in density and 97 ℃ in melting point. The second polyethylene was polymerized by Ziegler-Natta catalyst and was 4 g/10 minutes in melt flow rate, 0.918 g/cc in density and 106℃ in melting point.

Using the polyester and the polyethylene, the nonwoven fabric was obtained and the weight was 50 g/m ^{2} by the same method of the example 1.

Example 5

The polyethylene-terephthalate which was 0.70 in intrinsic viscosity [η] and 260 ℃ in melting point was prepared. On the other hand, the polyethylene which was 22 g/10 minutes in melt flow rate, 0.909 g/cc in density and 103℃ in melting point was prepared. This polyethylene was the mixture of the first polyethylene 70 weight mass and the second polyethylene 30 weight mass. The first polyethylene was polymerized by metallocene catalyst and was 28 g/10 minutes in melt flow rate, 0.906 g/cc in density and 97 ℃ in melting point. The second polyethylene was polymerized by Ziegler-Natta catalyst and was 14 g/10 minutes in melt flow rate, 0.918 g/cc in density and 106 ℃ in melting point.

Using the polyester and the polyethylene, the nonwoven fabric was obtained and the weight was 50 g/m ^{2} by the same method of the example 1.

Comparative Example 1

The polyethylene-terephthalate which was 0.70 in intrinsic

viscosity [η] and 260 ℃ in melting point was prepared. On the other hand, the polyethylene which was 25 g/10 minutes in melt flow rate, 0.957 g/cc in density and 130℃ in melting point was prepared. This polyethylene was a high density polyethylene polymerized by Ziegler-Natta catalyst.

Using the polyester and the high density polyethylene, the nonwoven fabric was obtained and the weight was 50 g/m^2 by the same method of the example 1.

Each nonwoven fabric obtained with the examples 1-5 and the comparative example 1 was measured or evaluated as the aboves which were described about the softness, the soft feeling, the smoothness feeling, the tensile strength and the adhesion strength of each non woven fabric. And the result were shown in Table 1.

[Table 1]

	examples					comparative example 1
	1	2	3	4	5	
the softness(g)	140	160	155	150	170	180
the soft feeling	1	2	1	1	2	3
the smoothness feeling	Bad	Mid.	Bad	Bad	Good	Bad
the tensile strength (N/5 cm in width)						
MD direction	205	216	250	217	180	220
CD direction	108	88	98	95	70	117
the adhesion strength (N)						
100℃	20.6	20.0	15.7	20.5	15.7	0
110℃	27.4	22.3	20.3	21.4	20.4	0
130℃	31.0	26.1	28.2	30.2	23.5	26.5

Furthermore, figure 4 was showing the micrograph of the nonwoven fabric obtained with the example 2. Figure 5 was showing the micrograph of the nonwoven fabric obtained with the example 3. Figure 6 was showing the micrograph of the nonwoven fabric obtained with the example 4. Figure 7 was showing the micrograph of the nonwoven fabric obtained with the example 5.

In the nonwoven fabrics obtained with the examples 1-5, each of the continuous fibers had irregular unevenness on the each surface along

the axial direction and circular direction of the fiber. On the other hand, in the nonwoven fabrics obtained with the comparative example 1, each of the continuous fibers had smooth on the each surface along the axial direction of the fiber. The each sheath-core type bicomponent continuous fiber obtained with the examples had fine parts and thick parts in diameter by existing the irregular unevenness. Therefore, softness was given to the continuous fiber, as the result, the each of the nonwoven fabrics obtained with the examples 1-5 was softer and had more soft feeling than the nonwoven fabric obtained with the comparative examples 1. Because the visible ray was diffusely reflected for the irregular unevenness, the each of the nonwoven fabrics obtained with the examples 1-5 was more whitish than the nonwoven fabrics obtained with the comparative examples 1.

Generally speaking, because the first polyethylene polymerized metallocene catalyst had lower melting point, the mixture polyethylene using the first polyethylene had too lower melting point. Accordingly, the nonwoven fabrics obtained with the examples 1-5 had higher adhesion strength than the nonwoven fabric obtained with the comparative examples 1, even if the temperature to adhere was low. The configuration of the cross section of the core portion which was made of the polyester did not change along the axial direction of the fiber as the prior art. Accordingly, the nonwoven fabrics obtained with the examples 1-5 had the same tensile strength as the nonwoven fabric obtained with the comparative examples 1 because the core portion had substantially same diameter.